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DEPARTMENT OF FISH AND GAME

HAZARD ASSESSMENT OF THE INSECTICIDE METHIDATHION TO AQUATIC ORGANISMS IN THE SACRAMENTO-SAN JOAQUIN RIVER SYSTEM

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PREFACE

The California Department of Fish and Game (CDFG) is responsible for protection and management of fish and wildlife. The CDFG protects fish and wildlife from pesticide hazards through consultation with the California Environmental Protection Agency's Department of Pesticide Regulation (DPR) Pesticide Registration and Evaluation Committee and Pesticide Advisory Committee. The Regional Water Quality Control Boards also protect fish and wildlife by promulgating and enforcing water quality standards for pesticides and other toxic materials. In recognition of the need for applicable environmental standards for fish and wildlife, DPR contracted with CDFG to assess the effects of pesticides on fish and wildlife and to facilitate development of water quality criteria to protect aquatic organisms.

This document is the sixth in a series of pesticide hazard assessments. Hazard assessments have also been prepared for the herbicides molinate and thiobencarb, and the insecticides methyl parathion, carbofuran, chlorpyrifos, and diazinon.

Hazard Assessment of the Insecticide Methidathion to Aquatic Organisms in the Sacramento-San Joaquin River System

by

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SUMMARY

Freshwater and saltwater toxicity thresholds for the protection of aquatic organisms from the insecticide methidathion were developed and a hazard assessment was performed for California's Sacramento-San Joaquin River system.

Thirty-one tests on the acute and chronic toxicity of methidathion to aquatic animals were reviewed and evaluated. The most acutely sensitive freshwater species tested was the cladoceran *Ceriodaphnia dubia* with a mean 96-h LC_{50} value of 2.2 µg/L. The most acutely sensitive saltwater species tested was the mysid *Mysidopsis bahia* with a 96-h LC_{50} value of 0.7 µg/L. The lowest freshwater Maximum Acceptable Toxicant Concentration (MATC) was 0.83 µg/L for cladoceran *Daphnia magna*. The only available saltwater MATC was 0.04 µg/L for mysid *M. bahia.*

Because of the lack of data for methidathion, U.S. Environmental Protection Agency methods for establishing a Water Quality Criterion (WQC) could not be used. Acceptable data were available for only three of the eight freshwater and four of the eight saltwater taxa needed to derive a Final Acute Value (FAV). Therefore, FAVs were not calculated and the lowest LC_{50} values for freshwater and saltwater species were used as acute toxicity thresholds (ATT). The freshwater ATT was 2.2 µg/L; the saltwater ATT was 0.7 µg/L. An interim Final Acute-Chronic Ratio (FACR) value of 12 was calculated using acute and chronic values from the only two species for which acceptable acute and chronic data were available. The Final Chronic Values (FCV) for methidathion were also not calculated because of the lack of data. Instead, chronic toxicity thresholds (CTT) were derived by dividing the interim freshwater and saltwater ATTs by the interim FACR. The freshwater CTT was 0.2 µg/L. The saltwater CCT was 0.06 µg/L.

Methidathion has been detected in the Sacramento-San Joaquin River system at concentrations as high as 15.1 µg/L. More typical detected concentrations range from 0.07 to 2.45. A comparison of detected concentrations with toxicity data indicates that methidathion may present a hazard to aquatic organisms, particularly sensitive aquatic invertebrates.

Additional acute toxicity tests using freshwater species such as fathead minnow *Pimephales promelas*, rotifers *Philodina* sp. or *Keratella* sp., water beetles *Petodytes sp.*, amphipods *Gammarus fasciatus* or *G. lacustris*, and stoneflies *Pteronarcella badia* or *Claassenia sabulosa* are required to determine freshwater FAVs and FACRs. Additional acute toxicity tests should be performed using saltwater species such as dungeness crab *Cancer magister*, blue crab *Callinectes spaidus*, hermit crab *Pagurus longicarpus*, and rotifers *Brachionus plicatilis*. To better define the FACR, paired acute and chronic toxicity tests should also be conducted on fresh and saltwater fish and invertebrates.

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ACKNOWLEDGEMENTS

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INTRODUCTION

The organophosphate insecticide methidathion is used on alfalfa, nuts, stone fruits, citrus, and other crops. From 1988 to 1992, methidathion use in California ranged from 148,000 to 179,000 kilograms (Table 1) (DPR 1988-92). Most methidathion use in the Sacramento-San Joaquin River area occurs during winter.

The Central Valley Regional Water Quality Control Board (CVRWQCB) monitored eleven sites in the Sacramento-San Joaquin River system from January 13 to February 27, 1992 (Table 2). Detected concentrations ranged from 0.13 to 15.1 µg/L (CVRWQCB 1993). The California Department of Pesticide Regulation (DPR) monitored methidathion in the San Joaquin River system from August 1991 through February 1993 (Table 2). Detected concentrations ranged from 0.07 µg/L to 12.4 µg/L.

Hazards from methidathion to aquatic life in the Sacramento-San Joaquin River system were assessed by comparing expected toxic effects with methidathion concentrations detected in the Sacramento-San Joaquin River system. The toxic effects of methidathion were assessed by evaluating toxicity tests published in the scientific literature and corporate laboratory reports from confidential files submitted to DPR for pesticide registration. Toxicity tests on methidathion were evaluated for conformance with specific criteria adapted from the U.S. Environmental Protection Agency (EPA) and the American Society for Testing of Materials (ASTM). Although toxicity tests were not required to comply with all criteria, tests were rejected if they did not observe certain fundamental procedures, such as maintaining sufficient organism survival in control treatments. The California Department of Fish and Game's (CDFG) toxicity thresholds are based on data from accepted tests and procedures adapted from EPA (1985a) guidelines (Appendix A). The EPA has not established a Water Quality Criterion (WQC) for methidathion.

Table 1. Methidathion use in California 1988-1992[a]

Year	Kilograms	Hectares
1988	152,000	123,000
1989	159,000	142,000
1990	160,000	108,000
1991	148,000	112,000
1992	179,000	129,000

[a] California Department of Pesticide Regulation Pesticide Use Reports 1988-1992

Table 2. Concentrations of methidathion (μg/L) detected in the Sacramento-San Joaquin River system, August 1991 through February 1993.

Date	Location[a]	Concentration[b]
8/02/91	San Joaquin River at Patterson[b]	0.11[c]
2/19/92	San Joaquin River at Patterson[b]	0.07[c]
2/10/93	San Joaquin River at Patterson[b]	0.76[c]
1/20/92	San Joaquin River at Laird Park[b]	0.07[c]
2/13/92	San Joaquin River at Laird Park[b]	0.16[c]
2/19/92	San Joaquin River at Laird Park[b]	0.07[c]
3/09/92	San Joaquin River at Laird Park[b]	0.08[c]
2/10/93	San Joaquin River at Laird Park[b]	0.60[c]
2/11/93	San Joaquin River at Laird Park[b]	0.33[c]
2/15/93	San Joaquin River at Laird Park[b]	0.09[c]
2/17/92	San Joaquin River at Bowman Road[b]	0.23[c]
2/17/92	San Joaquin River at Bowman Road[b]	0.14[d]
2/09/93	San Joaquin River at Hills Ferry[b]	0.33[c]
2/10/93	San Joaquin River at Maze Blvd[b]	0.34[c]
1/25/94	San Joaquin River at Vernalis[b]	0.32[e]
1/26/94	San Joaquin River at Vernalis[b]	0.27[e]
1/27/94	San Joaquin River at Vernalis[b]	0.91[e]
1/28/94	San Joaquin River at Vernalis[b]	0.55[e]
1/29/94	San Joaquin River at Vernalis[b]	0.19[e]
1/30/94	San Joaquin River at Vernalis[b]	0.11[e]
1/31/94	San Joaquin River at Vernalis[b]	0.09[e]
2/01/94	San Joaquin River at Vernalis[b]	0.08[e]
2/03/94	San Joaquin River at Vernalis[b]	0.05[e]
2/09/94	San Joaquin River at Vernalis[b]	0.23[e]
2/10/94	San Joaquin River at Vernalis[b]	0.44[e]
2/11/94	San Joaquin River at Vernalis[b]	0.38[e]
2/12/94	San Joaquin River at Vernalis[b]	0.24[e]
2/13/94	San Joaquin River at Vernalis[b]	0.17[e]
2/14/94	San Joaquin River at Vernalis[b]	0.24[e]
2/15/94	San Joaquin River at Vernalis[b]	0.14[e]
2/16/94	San Joaquin River at Vernalis[b]	0.11[e]

2/19/94	San Joaquin River at Vernalis[b]	0.06[e]
2/20/94	San Joaquin River at Vernalis[b]	0.09[e]

Table 2. -Continued-

Date	Location[a]	Concentration[b]
2/21/94	San Joaquin River at Vernalis[b]	0.06[e]
2/22/94	San Joaquin River at Vernalis[b]	0.09[e]
2/23/94	San Joaquin River at Vernalis[b]	0.08[e]
2/24/94	San Joaquin River at Vernalis[b]	0.05[e]
2/03/92	Lone Tree Creek at Austin Road[b]	0.14[e]
2/10/92	Lone Tree Creek at Austin Road[b]	2.45[e]
2/10/92	French Camp Slough at Manthey[b]	0.19[c]
2/10/92	French Camp Slough at Manthey[b]	0.66[e]
2/17/92	Newman Wasteway[b]	0.56[c]
2/09/93	Newman Wasteway[b]	12.4[c]
2/17/92	Old River at Cohen Road[b]	0.13[e]
2/18/92	Merced River[b]	0.18[c]
2/18/92	Orestimba Creek[b]	0.56[c]
2/09/93	Orestimba Creek[b]	2.14[c]
2/18/92	Turlock Irrigation Drain #5[b]	0.33[c]
2/19/92	Ingram/Hospital Creek[b]	0.19[c]
2/08/93	Highline Spillway[b]	0.14[c]
2/10/93	Tuolumne River[b]	0.07[c]
1/27/92	Gilsizer Slough at G. Washington Road[f]	0.15[e]
2/03/92	Gilsizer Slough at G. Washington Road[f]	2.17[e]
2/10/92	Gilsizer Slough at G. Washington Road[f]	15.1[e]
2/17/92	Gilsizer Slough at G. Washington Road[f]	1.44[e]
1/26/94	Tower Bridge[f]	0.05[e]
1/27/94	Tower Bridge[f]	0.05[e]
2/09/94	Tower Bridge[f]	0.06[e]
2/09/94	Tower Bridge[f]	0.03[e]
2/10/94	Tower Bridge[f]	0.05[e]
2/11/94	Tower Bridge[f]	0.06[e]
2/10/92	Clark's Ditch at White Road[f]	0.97[e]
2/17/92	Clark's Ditch at White Road[f]	0.32[e]
2/10/92	Ledgewood Creek at Portsmouth Court[g]	0.32[e]

[a] Only dates and locations on which methidathion was detected are listed
[b] Location within the San Joaquin River Drainage Basin
[c] Data from monitoring by Department of Pesticide Regulation
[d] Data from monitoring by Central Valley Regional Water Quality Control Board
[e] Data from monitoring by U.S. Geological Survey
[f] Location within the Sacramento River Drainage Basin
[g] Ledgewood Creek flows into Suisun Marsh

ENVIRONMENTAL FATE

Methidathion is an organophosphate insecticide and acaricide (Merck 1989). Methidathion has a water solubility of 221 ppm and a soil adsorption coefficient (k_{OC}) of 341 cm^3/g (DPR 1994). Photolysis half-life ($t_{1/2}$) of methidathion in aqueous media has been reported as 103 hours (Burkhard 1978). Photolysis on sandy loam soil is biphasic; phase I $t_{1/2}$ is about nine days, and phase II $t_{1/2}$ is about 21 days. Samples kept in the dark had a photolysis $t_{1/2}$ of about 124 days (Saxena 1989). At a temperature of 20^{o}C and pH 7, the hydrolysis $t_{1/2}$ of methidathion is about 41 days (Burkhard 1978). The low k_{OC}, high water solubility, and relatively long half-life of methidathion indicate a potential to move offsite and reach surface water.

ACUTE TOXICITY TO AQUATIC ANIMALS

Twenty-five tests on the acute toxicity of methidathion to aquatic animals were evaluated (Appendix B). Seventeen of these tests were accepted (Table B-1) and eight were not accepted (Table B-2).

The EPA (1985a) guidelines recommend eight freshwater taxa for which data should be available to derive a freshwater Final Acute Value (FAV), and eight saltwater taxa to derive a saltwater FAV (Tables 3 and 4). However, acceptable data were available for only three of the freshwater (Table 3) and four of the saltwater (Table 4) taxa recommended by EPA (1985a). Data from additional taxa are needed to derive a freshwater (Table 3) and a saltwater (Table 4) FAV. Other species in these taxa could be tested instead of those listed.

Genus Mean Acute Values (GMAVs) were calculated using data from accepted acute toxicity tests and were ranked in ascending order (Tables 5 and 6). Freshwater GMAVs ranged from 2.2 µg/L for cladoceran *Ceriodaphnia dubia* to 12.4 μg/L for bluegill *Lepomis macrochirus*. Saltwater GMAVs ranged from 0.7 μg/L for mysid *Mysidopsis bahia*, to 7,610 μg/L for adult eastern oyster *Crassostrea virginica*.

Usually, the four lowest GMAVs are the most significant determinants in calculating a FAV. Because of the lack of data, however, FAVs were not calculated. Instead, the lowest LC_{50} values for freshwater and saltwater species were used as acute toxicity thresholds (ATT). The freshwater ATT was 2.2 μg/L; the saltwater ATT was 0.7 μg/L.

Table 3. Eight taxa recommended by the Environmental Protection Agency (1985a) for deriving a freshwater Final Acute Value (FAV), representative species for which acute toxicity data were available, and suggested species to provide the necessary data.

Taxa	Available Species	Suggested Species
1. One Salmonid	Rainbow trout	N/A[a]
2. Another family in class Osteichthyes	Bluegill	N/A[a]
3. Another family in phylum Chordata	None	Fathead minnow
4. One family not in phylum Arthropoda or Chordata	None	Rotifer
5. One insect family or any phylum not already represented	None	Water beetle
6. One planktonic crustacean	Cladoceran	N/A[a]
7. One benthic crustacean	None	Amphipod
8. Another insect	None	Stonefly

[a] Not applicable. Acceptable data available for taxa.

Table 4. Eight taxa recommended by the EPA (1985a) for deriving a saltwater FAV, representative species for which acute toxicity data were available, and suggested species to provide the necessary data.

Taxa	Available Species	Suggested Species
1, 2. Two families in phylum Chordata	Spot Sheepshead minnow	NA[a]
3. One family not in phylum Arthropoda or Chordata	Eastern oyster	NA[a]
4, 5, 6. Three other families not in phylum Chordata	None	Dungeness crab, blue crab, hermit crab
7. A mysid or penaeid	Mysid	NA[a]
8. One other family not already represented	None	Rotifer

[a] Not applicable. Acceptable data available for taxa.

Table 5. Ranked Genus Mean Acute Values (GMAV) from accepted acute toxicity tests on freshwater species

Rank	GMAV (µg/L)	Species
1	2.2[a]	Cladoceran *Ceriodaphnia dubia*
2	3.0[a]	Mysid[b] *Neomysis mercedis*
3	7.2[c]	Cladoceran *Daphnia magna*
4	12.1[a]	Rainbow trout[b] *Oncorhynchus mykiss*
5	12.4[a] Bluegill[b]	*Lepomis macrochirus*

[a] Species Mean Acute Value: Geometric mean of values from several toxicity tests on this species. Individual values are listed in Table A-1.

[b] Occurs in Sacramento-San Joaquin Estuary

[c] LC_{50} value from one toxicity test on this species

Table 6. Ranked Genus Mean Acute Values GMAVs from accepted acute toxicity tests on saltwater species

Rank	GMAV (µg/L)	Species
1	0.7[c]	Mysid *Mysidopsis bahia*
2	7.8[c]	Sheepshead minnow *Cyprinodon vareigatus*
3	7.9[c]	Eastern oyster (larval) *Crassostrea virginica*
4	15[c]	Pink shrimp *Panaeus duorarum*
5	32[c]	Spot *Leistomus xanthurus*
6	>1000[a]	Eastern oyster (juv) *Crassostrea virginica*
7	7610[c]	Eastern oyster (mature) *Crassostrea virginica*

[a] Species Mean Acute Value: Geometric mean of values from several toxicity tests on this species. Individual values are listed in Table A-1.

[b] Occurs in Sacramento-San Joaquin Estuary

[c] LC_{50} value from one toxicity test on this species

CHRONIC TOXICITY TO AQUATIC ANIMALS

Six chronic toxicity tests were evaluated (Appendix C). Four of these tests were accepted (Table C-1); two were not accepted (Table C-2). The lowest freshwater Maximum Acceptable Toxicant Concentration (MATC) was 0.83 μg/L for cladoceran *Daphnia magna*. The only saltwater MATC was 0.04 μg/L for mysid *Mysidopsis bahia.*

The EPA (1985a) guidelines specify calculating the Acute-Chronic Ratio (ACR) for a species using for the numerator the geometric mean of LC_{50} values and for the denominator the geometric mean of MATC values; the acute and chronic values should be from the same study. The guidelines also specify that freshwater and saltwater Final Acute-Chronic Ratio (FACR) values combine ACR values of freshwater and saltwater species, including a fish, an invertebrate, and an acutely sensitive species. The FACR value used to derive a freshwater Final Chronic Value (FCV) should include an acutely sensitive freshwater species; the FACR value used to derive a saltwater FCV should include a saltwater species. The other species may be freshwater or saltwater.

However, insufficient data were available to follow EPA (1985a) guidelines for deriving the FACR value. An interim FACR value of 12 was calculated using acute and chronic values from the only two species for which acceptable acute and chronic data were available, the freshwater cladoceran *Daphnia magna* and the saltwater mysid *Mysidopsis bahia* (Table 6). Both species are acutely sensitive invertebrates. No paired acute and chronic data for fish species were available, and the invertebrate acute and chronic data were from separate studies. Because of the lack of data, FCVs were not calculated. Instead, chronic toxicity thresholds were derived by dividing the freshwater and saltwater ATTs by the interim FACR. The freshwater and saltwater CTTs are 0.2 μg/L (2.2/12=0.18), and 0.06 (0.7/12=0.058), respectively.

Table 7. Acute-Chronic Ratios (ACR) for species for which acute and chronic toxicity data were available

Species	LC_{50} or SMAV (µg/L)	MATC $(NOEC \times LOEC)^{1/2}$ (µg/L)	ACR $(LC_{50}/MATC)$
Mysid[a] *Mysidopsis bahia*	0.7	0.04	17.5
Cladoceran[b] *Daphnia magna*	7.2	0.83[c]	8.7
Final Acute-Chronic Ratio: 12[d]			

[a] Saltwater species

[b] Freshwater species

[c] Geometric mean of MATC values from two chronic toxicity tests

[d] Geometric mean of ACR values

TOXICITY TO AQUATIC PLANTS

One test on the toxicity of methidathion to aquatic plants was evaluated (Appendix D) to derive a Final Plant Value (FPV). The FPV is the lowest concentration of pesticide that demonstrates a biologically important toxic endpoint (EPA 1985a). The FPV, derived from one toxicity test with freshwater alga *Scenedesmus subspicatus* was 11,000 µg/L. Because it is an insecticide, methidathion is likely to be more toxic to animals than to plants, and criteria that protect animals will also protect plants.

HAZARD ASSESSMENT

Toxicity Thresholds

The EPA (1985a) guidelines specify that the WQC consists of two concentrations, the Criterion Maximum Concentration (CMC) and the Criterion Continuous Concentration (CCC). The CMC is one-half the FAV, and the CCC is the lowest of three values: the FCV, the FPV, or the Final Residue Value (Appendix A).

Because of the lack of data for methidathion, EPA (1985a) methods for establishing a WQC cannot be followed. Instead, the freshwater and saltwater CTTs 0.2 µg/L and 0.06 µg/L, respectively, will be used.

Hazard to Aquatic Animals

Although methidathion has been detected in the Sacramento-San Joaquin River system at concentrations as high as 15.1 µg/L, typical values range from 0.07 to 2.45 µg/L. Monitoring data suggest that methidathion may be a chronic contaminant in the San Joaquin River system (Table 2). A comparison of detected concentrations with toxicity data indicates that methidathion may present a hazard to aquatic organisms, particularly to sensitive aquatic invertebrates. The lowest LC_{50} and MATC values for freshwater invertebrates were 2.2 and 0.83 µg/L, respectively. Monitoring data for saltwater are not available, but methidathion concentrations are likely to be much lower than in freshwater.

Data Requirements

Acute toxicity data were available for only three of the eight freshwater and four of the eight saltwater families adapted from EPA (1985a) recommendations (Tables 3 and 4). Additional acute toxicity tests using freshwater species such as fathead minnow *Pimephales promelas*, rotifers *Philodina* sp. or *Keratella* sp., water beetles *Petodytes sp.*, amphipods *Gammarus fasciatus* or *lacustris*, and stoneflies *Pteronarcella badia* or *Claassenia sp* are required to determine freshwater FAVs and FCVs. Additional acute toxicity tests should be performed using saltwater species such as dungeness crab *Cancer magister*, blue crab *Callinectes sapidus*, hermit crab *Pagurus longicarpus*, and rotifers *Brachionus* *plicatilis*. To better define the FACR, paired acute and chronic toxicity tests should also be conducted on freshwater and saltwater fish, and invertebrate species.

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APPENDIX A. Procedures used by the California Department of Fish and Game to prepare hazard assessments

The California Department of Fish and Game's (CDFG) hazard assessment procedure includes evaluation of toxicity studies, establishment of the Water Quality Criterion (WQC), and assessment of potential hazards.

Acute and chronic toxicity data are obtained from studies published in scientific literature and laboratory reports required for pesticide registration by the U. S. Environmental Protection Agency (EPA) and the California Department of Pesticide Regulation. The CDFG evaluates these tests for compliance with standards adapted from the EPA and the American Society for Testing and Materials (ASTM). Standards include test type and methods, species tested, and water quality and toxicant maintenance. Although studies need not comply with every standard, tests are rejected if they do not observe certain fundamental procedures or if several important standards are not met. Studies are also rejected if they do not contain sufficient information to be properly evaluated and the necessary information cannot be obtained from the researcher.

Acute toxicity data from acceptable tests on freshwater and saltwater organisms are used to determine a Final Acute Value (FAV). The EPA (1985a) guidelines recommend eight categories of freshwater organisms for which data should be available for deriving a freshwater FAV, and eight categories of saltwater organisms for deriving a saltwater FAV.

The FAV is calculated as follows:

1. Species Mean Acute Values (SMAV) are calculated as the geometric mean of EC_{50} values and LC_{50} values from all accepted toxicity tests performed on that species.

2. Genus Mean Acute Values (GMAV) are calculated as the geometric mean of all SMAVs for each genus.

3. GMAVs are ranked (R) from "1" for the lowest to "N" for the highest. Identical GMAVs are arbitrarily assigned successive ranks.

4. The cumulative probability (P) is calculated for each GMAV as R/(N+1).

5. The four GMAVs with cumulative probabilities closest to 0.05 are selected. If fewer than 59 GMAVs are available, these will always be the four lowest GMAVs.

6. The FAV is calculated using the selected GMAVs and Ps, as follows:

$$S^2 = \frac{3((\ln GMAV)^2)-((3(\ln GMAV))^2/4)}{3(P) - ((3(\%P))^2/4)}$$

$$L = (3(\ln GMAV) - S(3(\%P)))/4$$
$$A = S(\%0.05) + L$$

$$FAV = e^A$$

Chronic toxicity data from acceptable tests on freshwater and saltwater organisms are used to determine a Final Chronic Value (FCV). If data are available for the eight families, the FCV is calculated using the same procedure as described for the FAV.

If insufficient data are available, the FCV is calculated as follows:

1. Chronic values are determined by calculating the geometric mean of the NOEC and the LOEC values from accepted chronic toxicity tests.

2. Acute-Chronic Ratios (ACR) are calculated for each chronic value for which at least one corresponding acute value is available. The acute test(s) should be part of the same study as the chronic test.

3. The Final ACR (FACR) is calculated as the geometric mean of all the species mean ACRs available for both freshwater and

saltwater species.

4. FCV = FAV/FACR.

Plant toxicity data from algae or aquatic vascular plants are used to determine a Final Plant Value (FPV). The FPV is the lowest result from a test with a biologically important endpoint.

EPA (1985a) guidelines specify that a WQC consist of two concentrations, the Criterion Maximum Concentration (CMC), and the Criterion Continuous Concentration (CCC). The CMC is equal to one-half the FAV. The CCC is equal to the lowest of three values: the FAV, the FCV, or the Final Residue Value (FRV). The FRV is intended to prevent pesticide concentrations in commercially or recreationally important species from affecting marketability because of excedence of applicable action levels, and to protect wildlife that consume aquatic organisms (EPA 1985a). The WQC can be lowered to protect important species.

The WQC is stated as follows: (Freshwater/saltwater) aquatic organisms should not be affected unacceptably if the four-day average concentration of (pesticide) does not exceed (CCC value), and if the one-hour average concentration does not exceed (CMC value) more than once every three years on the average.

Hazard assessment is an iterative process in which new data are evaluated to refine the WQC. Hazard assessments may recommend additional toxicity tests with sensitive species and commonly-used test organisms.

APPENDIX B. Abstracts of acute toxicity tests.

Accepted acute toxicity tests - The following tests used accepted test methods.

Carr (1991a) - In 1991, a 96-h flow-through toxicity test was performed by Toxikon Environmental Sciences on technical grade methidathion (95%) with mature eastern oyster *Crassostrea virginica*. EPA (1985b) test standards were used. Five concentrations were tested and solvent and water controls were used. Concentrations were measured at the beginning and end of the test and measured concentrations averaged 84% of nominal concentrations. Water quality parameters during the test were: temperature of 26 to 27EC; pH of 7.9 to 8.0; dissolved oxygen of 2.0 to 6.8 mg/L; and salinity of 26 to 28$^{o}/_{oo}$. Control survival was 100%. The EC_{50} and NOEC values, based on shell growth, were 7610 µg/L and 1450 µg/L, respectively.

CDFG (1992a) - In 1992, a 96-h static test was performed by the CDFG Aquatic Toxicology Laboratory on technical grade methidathion (94.3%) with <24-h old neonate cladoceran *Ceriodaphnia dubia*. EPA (1985b) and ASTM (1990) testing standards were used. Five concentrations of methidathion were tested in replicate and solvent and water controls were used. Measured concentrations were 100-160% of nominal concentrations. Water quality parameters during the test averaged: temperature of 24.5^{o}C; pH of 8.51; hardness of 120.5 mg/L; alkalinity of 95.0 mg/L; and dissolved oxygen of 7.6 mg/L. Control survival was 90% and 100% in solvent and water controls, respectively. The 96-h LC_{50} value was 2.44 µg/L, the NOEC and LOEC values, based on immobilization, were 1.05 µg/L and 2.10 µg/L, respectively.

CDFG (1992b) - In 1992, a 96-h static test was performed by the CDFG Aquatic Toxicology Laboratory on technical grade methidathion (94.3%) with $\leq$5-d old mysid *Neomysis mercedis*. EPA (1985b) and ASTM (1990) testing standards were used. Five concentrations of methidathion were tested in replicate and solvent and water controls were used. Measured concentrations were 72-103% of nominal concentrations. Water quality parameters during the test averaged: temperature of 17.1°C; pH of 8.4; hardness of 492.1 mg/L; conductivity of 3311.4 µs/cm; salinity of 2.03°/oo; alkalinity of 151 mg/L and dissolved oxygen of 9.06 mg/L. Control survival was 100% for both solvent and water controls. The 96-h LC_{50} value was 2.82 µg/L, the NOEC and LOEC values, based on immobilization, were 1.43 µg/L and 2.68 µg/L, respectively.

CDFG (1992c) - In 1992, a 96-h static test was performed by the CDFG Aquatic Toxicology Laboratory on technical grade methidathion (94.3%) with <24-h old neonate cladoceran *Ceriodaphnia dubia*. EPA (1985b) and ASTM (1990) testing standards were used. Five concentrations of methidathion were tested in replicate and solvent and water controls were used. Measured concentrations were 77-106% of nominal concentrations. Water quality parameters during the test averaged: temperature of 24.6°C; pH of 8.4; hardness of 121.5 mg/L; conductivity of 364.3 µs/cm; alkalinity of 97 mg/L and dissolved oxygen of 7.58 mg/L. Control survival was 100% for both solvent and water controls. The LC_{50} value was 1.96 µg/L, the NOEC and LOEC values based on immobilization were 1.45 µg/L and 2.65 µg/L, respectively.

CDFG (1992d) - In 1992, a 96-h static toxicity test was performed by the CDFG Aquatic Toxicology Laboratory on technical grade methidathion (percent active ingredient not given) with ≤4-d mysid *Neomysis mercedis*. EPA (1985b) and ASTM (1990) testing standards were used. Five concentrations of methidathion were tested in replicate and solvent and water controls were used. Measured concentrations were 77 to 99% of nominal concentrations. Water quality parameters during the test averaged: temperature of 17.0°C; pH of 8.36; hardness of 489 mg/L; conductivity of 3276 μs/cm; salinity of 2.07$^{o}/_{oo}$; alkalinity of 152 mg/L; and dissolved oxygen of 8.84 mg/L. Survival was 100% for both solvent and water controls. The 96-h LC_{50} value was 3.2 μg/L, the NOEC and LOEC values, based on immobilization, were 1.45 μg/L and 3.05 μg/L respectively.

Mayer (1987), pers. comm. (1994) - In 1987, 48-h and 96-h flow-through toxicity tests were performed by Gulf Breeze Environmental Research Laboratory on technical grade methidathion (98.5%) with juvenile pink shrimp *Penaeus duorarum*, juvenile eastern oyster *Crassostrea virginica* (two tests) and juvenile spot *Leiostomus xanthurus*. Test methods were similar to ASTM (1980). Five concentrations of methidathion were tested and a control was used. Concentrations of methidathion were not measured during the test. Water quality parameters during the test averaged: temperature of 23^{o}C (shrimp), 13^{o}C and 29^{o}C (oyster), and 12^{o}C (spot); salinity of 22$^{o}/_{oo}$ to 26$^{o}/_{oo}$; pH and dissolved oxygen were monitored but not given. Control survival was $\geq$90%. The 48-h EC_{50} for *P. duorarum* was 15 μg/L, 96-h EC_{50} for both *C. virginica* tests was >1,000 μg/L, and 48-h LC_{50} values for *L. xanthurus* was 32 μg/L.

Mayer and Ellersieck (1986) - In 1965, 96-h static toxicity tests were performed by the Columbia National Fisheries Laboratories of the U.S. Fish and Wildlife Service on technical grade methidathion (98.5%) with bluegill *Lepomis macrochirus* and rainbow trout *Oncorhynchus mykiss* (life stages not given). Test methods similar to EPA (1975) were used. Six concentrations of methidathion were tested with bluegill and five concentrations were tested with trout. Controls were used. Concentrations of methidathion were not measured during the tests. Water quality parameters during the test averaged: temperature of 24^{o}C (bluegill) and 12^{o}C (trout); pH of 7.4 and hardness of 44 mg/L for both tests. Control survival was $\geq$90% for both tests. The

96-h LC_{50} value for bluegill and trout were 9.0 μg/L and 14.0 μg/L, respectively.

Schupner (1981a) - In 1981, a 96-h static toxicity test was performed by Union Carbide on technical grade methidathion (93.8%) with five month old bluegill *Lepomis macrochirus*. APHA (1975) and EPA (1975) test standards were used. Five concentrations were tested in replicate and solvent and water controls were used. Concentrations were measured at the beginning of the test and measured concentrations were used for all calculations. Water quality parameters during the test were: temperature of 20 to 22.8° C; pH of 7.09 to 7.55; dissolved oxygen of 6.1 to 9.3 mg/L; and hardness of 48 mg/L. Control survival was 100%. The LC_{50} value for the bluegill was 17.2 μg/L.

Schupner (1981b) - In 1981, a 96-h static toxicity test was performed by Union Carbide on technical grade methidathion (93.8%) with three month old rainbow trout *Oncorhynchus mykiss*. APHA (1975) and EPA (1975) test standards were used. Five concentrations were tested in replicate and solvent and water controls were used. Concentrations were not measured. Water quality parameters during the test were: temperature of 11.7 to 12.5° C; pH of 7.0 to 7.1; dissolved oxygen of 4.7 to 9.5 mg/L; and hardness of 3.8 mg/L. Control survival was 100% The LC_{50} value for rainbow trout was 10.5 μg/L.

Surprenant (1986) - In 1986, a 48-h static toxicity test was performed by Springborn Bionomics on technical grade methidathion (100%) with larval eastern oysters *Crassostrea virginica*. APHA (1985), ASTM (1980), and EPA (1985b) test standards were used. Five concentrations were tested with three replicates and solvent and water controls were used. Concentrations were measured at the beginning and end of the test and measured concentrations averaged 57% of nominal concentrations. Water quality parameters during the test were: temperature of 20EC; pH of 7.9 to 8.1; dissolved oxygen of 7.0 to 7.5 mg/L; and salinity of $32^{o}/_{oo}$. Abnormal development occurred in 15% of the control organisms. The EC_{50}, based on abnormal development, was 7.9 µg/L.

Union Carbide (1976) - In 1976, a 48-h static toxicity test was performed by Aquatic Environmental Sciences on technical grade (percent active ingredient not given) methidathion with <20-h first instar cladoceran *Daphnia magna*. EPA (1975) and APHA (1971) testing standards were used. Five concentrations of methidathion were tested in replicate and solvent and water controls were used. Methidathion concentrations were not measured during the test. Water quality parameters during the test averaged; temperature of 17°C; pH of 7.6; hardness of 40 mg/L; conductivity of 130 µmhos/cm; and alkalinity of 20 mg/L. Control survival was 100% for both solvent and water controls. The 48-h LC_{50} value was 7.2 µg/L and the NOEC value was 1.8 µg/L.

Ward (1984) - In 1984, 96-h static toxicity tests were performed by Springborn Bionomics on technical grade Supracide® (97.7%) with five to six day old mysids *Mysidopsis bahia* and juvenile sheepshead minnows *Cyprinodon vareigatus*. ASTM (1980) test standards were used. Five concentrations were tested with two replicates and solvent and water controls were used. Concentrations were measured at the beginning of the tests and measured concentrations averaged 80% (for mysids) and 84% (for minnows) of nominal concentrations. Water quality parameters during the mysid and minnow tests, respectively, were: temperature of 22 to 23 °C and 21 to 22 °C; pH of 7.9 to 8.3 and 7.3 to 8.3; dissolved oxygen of 7.3 to 5.4 and 7.9 to 3.8 mg/L; and salinity of 19 to $20^{o}/_{oo}$. Control survival was 100%. The LC_{50} values for mysids and sheepshead minnows were 0.7 and 7.8 µg/L, respectively.

Unaccepted acute toxicity tests - The following tests did not use accepted test methods and/or produce accepted results.

Carr (1991b) - In 1991, a 96-h flow-through toxicity test was performed by Toxikon on Supracide^R (25.2%) with juvenile sheepshead minnows *Cyprinodon variegatus*. EPA (1982) test standards were used. Five concentrations were tested and solvent and water controls were used. Concentrations were measured at the beginning and end of the test and measured concentrations averaged 77% of nominal concentrations. Water quality parameters during the test were: temperature of 22 to 25.2^o C; pH of 8.2 to 8.4; dissolved oxygen of 0.9 to 6.9 mg/L; and salinity of 18 to 21$^o/_{oo}$. Control survival was 100% The LC_{50} and NOEC values for sheepshead minnows were 28.3 and 9.12 µg A.I./L, respectively. These values were not used because the formulation was too low in active ingredient and the dissolved oxygen levels were too low.

Carr (1991c) - In 1991, a 96-h flow-through toxicity test was performed by Toxikon on Supracide^R (25.2%) with adult eastern oysters *Crassostrea virginica*. EPA (1985b) test standards were used. Five concentrations were tested and a water control was used. Concentrations were measured at the beginning and end of the test. Measured concentrations averaged 14% of nominal concentrations. Results were based on measured concentrations. Water quality parameters during the test were: temperature of 22 to 24.6^o C; pH of 7.9 to 8.2; dissolved oxygen of 5.6 to 7.1 mg/L; and salinity of 22 to 28$^o/_{oo}$. Control survival was 100% The LC_{50} value for eastern oysters was 6,470 µg A.I./L. The EC_{50} value, based on new shell growth, was 1,100 µg A.I./L. These values were not used because the formulation was too low in active ingredient and measured concentrations varied too much from nominal.

Cebrian et al. (1990) - In 1990, a 96-h static toxicity test was performed by University of Valencia, Spain on technical grade methidathion (95%) with crayfish *Procambarus clarkii* (life stage not given). No test standards were mentioned. Three concentrations were tested and solvent and water controls were used. Concentrations were not measured. Water quality parameters during the test were: temperature of 22° C; pH of 7.9; and hardness of 250 mg/L. Control survival was not given. Effects were not given. This test was not accepted because an inadequate number of concentrations were tested, pertinent values were not determined, and essential information, such as control survival and dissolved oxygen level, was not given.

Ferrando et al.(1991) - In 1991, a 96-h flow-through toxicity test was performed by the University of Valencia, Spain on technical grade methidathion (95.0%) with European eel *Anguilla* (life stage not given). EPA (1975) testing methods were used. The number of concentrations tested was not given but a solvent control was used. Concentrations were not measured during the test. Water quality parameters during the test averaged: temperature of 20°C; pH of 7.9; hardness 250 mg/L; and alkalinity of 4.1 mmol/L. Control survival was 100%. The 96-h LC_{50} value was 1510 µg/L. This test was not accepted because essential information such as dissolved oxygen levels, concentration scale, and mortality at each concentration was not given.

Lelievre (1991a) - In 1991, a 96-h static toxicity test was performed by Springborn Laboratories on Supracide® (25.2%) with juvenile bluegill *Lepomis macrochirus*. APHA (1985), ASTM (1980), and EPA (1975, 1985c) test standards were used. Five concentrations were tested in replicate and solvent and water controls were used. Concentrations were measured at the beginning and end of the test. Measured concentrations averaged 75% of nominal concentrations. Water quality parameters during the test were: temperature of 22 to 23° C; pH of 7.3 to 7.6; dissolved oxygen of 4.2 to 9.5 mg/L; and hardness of 38 mg/L. Control survival was 100% The LC_{50} value for bluegill was 8.2 µg

A.I./L. The NOEC value was <4.2 µg A.I./L. These values were not used because the pesticide formulation was too low in active ingredient.

<u>Lelievre (1991b)</u> - In 1991, a 96-h static toxicity test was performed by Springborn Laboratories on Supracide[R] (25.2%) with the rainbow trout *Oncorhynchus mykiss* (life stage not given). APHA (1985), ASTM (1980), and EPA (1975, 1985c) test standards were used. Seven concentrations were tested in replicate and solvent and water controls were used. Concentrations were measured at the beginning and end of the test. Measured concentrations averaged 58% of nominal concentrations. Water quality parameters during the test were: temperature of 11 to 12^{o} C; pH of 6.7 to 7.3; dissolved oxygen of 5.9 to 9.7 mg/L; and hardness of 38 mg/L. Control survival was 100% The LC_{50} value for rainbow trout was 6.6 µg A.I./L. The NOEC value, based on mortality, was 1.1 µg A.I./L. These values were not used because the formulation was too low in active ingredient.

<u>Lelievre (1991c)</u> - In 1991, a 48-h static toxicity test was performed by Springborn Bionomics on Supracide[R] (25.2%) with <24-h cladocerans *Daphnia magna*. APHA (1985) and EPA (1975, 1985d) test standards were used. Five concentrations were tested with five replicates and solvent and water controls were used. Concentrations were measured at 48-h intervals during the test and measured concentrations averaged 67% of nominal concentrations. Water quality parameters during the test were: temperature of 19 to 21^{o} C; pH of 7.9 to 8.1; dissolved oxygen of 7.6 to 8.9 mg/L; and hardness of 170 mg/L. Control survival was 100% The EC_{50} value, based on immobilization, was 3.0 µg A.I./L. The NOEC value was 0.92 µg A.I./L. These values were not used because the formulation was too low in active ingredient.

<u>Ward (1991)</u> - In 1991, a 96-h flow-through toxicity test was performed by Toxikon Laboratories on Supracide[R] (25.2%) with

post-larval mysid, *Mysidopsis bahia*. EPA (1982) test standards were used. Five concentrations were tested in replicate and solvent and water controls were used. Concentrations were measured at the beginning and end of the test. Measured concentrations averaged 80% of nominal concentrations. Water quality parameters during the test were: temperature of 20 to 24^{o} C; pH of 8.2 to 8.4; dissolved oxygen of 3.1 to 8.5 mg/L; and salinity of 19 to 20$^{o}/_{oo}$. Control survival was 95 to 100% The LC_{50} value for *M. bahia* was 0.59 μg A.I./L. The NOEC value, based on mortality and sublethal effects, was 0.24 μg A.I./L. These values were not used because the formulation was too low in active ingredient.

Table B-1. Values (µg/L) from accepted tests on the acute toxicity of methidathion to aquatic animals.

Species	Life Stage[a]	Method[b]	Formulation[a]	Salinity/ Hardness	Test Length	Effect	Values (95% C.L.)[a,c]	Reference
Bluegill *Lepomis macrochirus*	N/A	S,U	Technical (98.5%)	44 mg/L as $CaCO_3$	96-h	LC_{50}	9.0 (6.1-13.3)	Mayer and Ellersieck 1986
Bluegill *Lepomis macrochirus*	5 month	F,M	Technical (93.8%)	48 mg/L as $CaCO_3$	96-h	LC_{50}	17.2 (12.2)	Schupner 1981a
Cladoceran *Ceriodaphnia dubia*	<24-h	S,M	Technical (94.3%)	120.5 mg/L as $CaCO_3$	96-h	LC_{50}	2.44 (2.1-3.4)	CDFG 1992a
Cladoceran *Ceriodaphnia dubia*	<24-h	S,M	Technical (94.3%)	121.5 mg/L as $CaCO_3$	96-h	LC_{50}	1.96 (1.45-2.65)	CDFG 1992c
Cladoceran *Daphnia magna*	<20-h	S,U	Technical (N/A)	40 mg/L as $CaCO_3$	48-h	LC_{50}	7.2 (5.9-8.8)	Union Carbide 1976
Eastern oyster *Crassostrea virginica*	Mature	F,M	Technical (95%)	26-28$^{o}/_{oo}$	96-h	EC_{50}	7610 (4760-10200)	Carr 1991a
Eastern oyster *Crassostrea virginica*	Larval	F,M	Technical (100%)	32$^{o}/_{oo}$	48-h	EC_{50}	7.9 N/A	Surprenant 1986
Eastern oyster *Crassostrea virginica*	Juv.	F,U	Technical (98.5%)	25$^{o}/_{oo}$	96-h	EC_{50}	>1000 (N/A)	Mayer 1987
Eastern oyster *Crassostrea virginica*	Juv.	F,U	Technical (98.5%)	22$^{o}/_{oo}$	96-h	EC_{50}	>1000 (N/A)	Mayer 1987
Mysid *Mysidopsis bahia*	5-6-d	S,M	Technical (97.7%)	19-20$^{o}/_{oo}$	96-h	LC_{50}	0.7 (0.44-0.90)	Ward 1984
Mysid *Neomysis mercedis*	≤5-d	S,M	Technical (94.3%)	492.1 mg/L as $CaCO_3$	96-h	LC_{50}	2.82 (1.43-5.88)	CDFG 1992b
Mysid *Neomysis mercedis*	<5-d	S,M	Technical (94.3%)	489 mg/L as $CaCO_3$	96-h	LC_{50}	3.2 (1.4-6.0)	CDFG 1992d
Pink shrimp *Penaeus duorarum*	Juv.	F,U	Technical (98.5%)	26$^{o}/_{oo}$	48-h	EC_{50}	15 (N/A)	Mayer 1987

Rainbow trout *Oncorhynchus mykiss*	N/A	S,U	Technical (98.5%)	44 mg/L as $CaCO_3$	96-h	LC_{50}	14 (9.0-22.0)	Mayer and Ellersieck 1986

Table B-1. Continued -2-

Species	Life Stage[a]	Method[b]	Formulation[a]	Salinity/ Hardness	Test Length	Effect	Values (95% C.L.)[a,c]	Reference
Rainbow trout *Oncorhynchus mykiss*	3 month	F,U	Technical (93.8%)	38 mg/L as $CaCO_3$	96-h	LC_{50}	10.5 (7.3-15.1)	Schupner 1981b
Sheepshead minnow *Cyprinodon vareigatus*	Juv.	S,M	Technical (97.7%)	$22^{o}/_{oo}$	96-h	LC_{50}	7.8 (6.9-11)	Ward 1984
Spot *Leiostomus xanthurus*	Juv.	F,U	Technical (98.5%)	$25^{o}/_{oo}$	48-h	LC_{50}	32 (N/A)	Mayer 1987

[a] N/A = Not Available

[b] S = Static F = Flow-through M = Measured concentrations U = Unmeasured concentrations

[c] 95% Confidence limits

Table B-2. Values (µg/L) from unaccepted tests on the acute toxicity of methidathion to aquatic animals.

Species	Life Stage[a]	Method[b]	Formulation	Salinity/ Hardness	Test Length	Effect	Values (95% C.L.)[a,c]	Reference	Test Deficiencies[d]
Bluegill *Lepomis macrochirus*	Juvenile	S,M	Supracide^{R} (25.2%)	38 mg/L as $CaCO_3$	96-h	LC_{50}	8.2 (5.7-11)	Lelievre 1991a	1,2
Cladoceran *Daphnia magna*	<24-h	S,M	Supracide^{R} (25.2%)	170 mg/L as $CaCO_3$	48-h	EC_{50}	3.0 (2.8-3.4)	Lelievre 1991c	1
Crayfish *Procambarus clarkii*	N/A	S,U	Technical (95%)	150 mg/L as $CaCO_3$	96-h	NA	NA	Cebrian et al. 1990	3,4,5,6
Eastern oyster *Crassostrea virginica*	N/A	F,M	Supracide^{R} (25.2%)	22-28$^{o}/_{oo}$	96-h	LC_{50}	6470	Carr 1991c	1,7
Eel *Anguilla anguilla*	N/A	F,U	Technical (95.0%)	250 mg/L as $CaCO_3$	96-h	LC_{50}	1510 (1160-2030)	Ferrando et al. 1991	3,4,5
Mysid *Mysidopsis bahia*	Post-larval	F,M	Supracide^{R} (25.2%)	19-20$^{o}/_{oo}$	96-h	LC_{50}	0.59 (0.51-0.67)	Ward 1991	1,2,3
Rainbow trout *Oncorhynchus mykiss*	N/A	S,M	Supracide^{R} (25.2%)	38 mg/L as $CaCO_3$	96-h	LC_{50}	6.6 (4.6-9.0)	Lelievre 1991b	1
Sheepshead minnow *Cyprinodon vareigatus*	Juvenile	F,M	Supracide^{R} (25.2%)	18-21 $^{o}/_{oo}$	96-h	LC_{50}	28.3 (24.3-32.4)	Carr 1991b	1,2

[a] NA = Not available

[b] S = Static F = Flow through M = Measured concentrations U = Unmeasured concentrations

[c] 95% Confidence limits

[d] 1 = Formulation unknown or too low in active ingredient
2 = Unacceptable or unmeasured dissolved oxygen level
3 = Unacceptable mortality range or mortality range not given
4 = Essential information lacking
5 = Inadequate number of concentrations tested
6 = No pertinent values determined

7 = Measured concentrations varied too much from nominal

APPENDIX C. Abstracts of chronic toxicity tests.

Accepted chronic toxicity tests- The following tests used accepted test methods.

Forbis (1984), pers. comm. (1994) - In 1984, a 21-d flow-through toxicity test was performed by Analytical Biochemistry Laboratories on Supracide[R] (97.2 to 99.2%) with <24-h old cladoceran *Daphnia magna*. EPA (1975) test standards were used. Five concentrations were tested with four replicates and solvent and water controls. Concentrations were measured at three to seven day intervals during the test and measured concentrations averaged 90 to 103% of nominal concentrations. Water quality parameters during the test were: temperature of 20 to 21^{o} C; pH of 8.2 to 8.4; dissolved oxygen of 8.1 to 8.9 mg/L; and hardness of 225 to 275 mg/L. Control survival was 100%. The NOEC, LOEC, and MATC values, based on mortality, reproduction, and growth, were 0.51, 1.0, and 0.71 µg/L, respectively.

McCallister (1984) - In 1984, a 35-d flow-through toxicity test was performed by Analytical Biochemistry Laboratories on methidathion (97.2 to 99.2%) with early stage fathead minnows, *Pimephales promelas*. ASTM (1981) test standards were used. Five concentrations were tested with four replicates and solvent and water controls. Concentrations were measured weekly during the test and measured concentrations averaged 75 to 84% of nominal concentrations. Water quality parameters during the test were: temperature of 24 to 27^{o} C; pH of 7.8 to 8.3; dissolved oxygen of 7.3 to 9.3 mg/L; and hardness of 225 to 275 mg/L. Control survival was 91% in water and 98% in solvent. The NOEC, LOEC, and MATC values based on growth were 6.1 µg/L, 12 µg/L, and 8.56 µg/L, respectively.

Putt (1991) - In 1991, a 21-d flow-through toxicity test was performed by Springborn Bionomics on methidathion (99.2%) with 24-h old cladoceran *Daphnia magna*. EPA (1985e) test standards were used. Five concentrations were tested with four replicates and solvent and water controls. Concentrations were measured weekly during the test and measured concentrations averaged 86% of nominal concentrations. Water quality parameters during the test were: temperature of 18 to 21^{o} C; pH of 7.9 to 8.4; dissolved oxygen of 8.3 to 8.6 mg/L; and hardness of 170 to 180 mg/L. Control survival was 93% in the water and 98% in the solvent. The EC_{50} value based on mortality, reproduction, and growth was 0.79 µg/L. NOEC, LOEC, and MATC values based on mortality, reproduction, and growth were 0.72 µg/L, 1.3 µg/L, and 0.97, respectively.

Surprenant (1985) - In 1984, a 21-d flow-through toxicity test was performed by Springborn Bionomics on methidathion (100%) with post-larval mysid *Mysidopsis bahia*. ASTM (1983) test standards were used. Five concentrations were tested with four replicates and solvent and water controls. Concentrations were measured at four to seven day intervals during the test and averaged 34 to 81% of nominal concentrations. Results were based on measured concentrations. Water quality parameters during the test were: temperature of 22 to 26^{o} C; pH of 8.0 to 8.1; dissolved oxygen of 4.8 to 7.1 mg/L; and salinity of 28 to 31$^{o}/_{oo}$. Control survival was 98% in water and 88% in solvent. The NOEC, LOEC, and MATC values based on mortality, reproduction, and growth were 0.022, 0.061, and 0.037 µg/L, respectively.

Unaccepted chronic toxicity tests - The following tests did not use accepted test methods and/or produce acceptable results

Ciba-Geigy Corp. (1966) - In 1966, a 7-d flow-through toxicity test was performed by Woodard Research Corporation on methidathion (percent active ingredient not given) with eastern oyster *Crassostrea virginica*. No commonly recognized testing standards were used. One concentration and a solvent control was used. Methidathion concentrations were not measured. Water quality parameters during the test were: temperature 13 to 15°C; and salinity of 11.8$^{o}/_{oo}$. Solvent control survival was 100%. There was no effect on shell growth or mortality at 1.0 mg/L. This test was not accepted because no pertinent values were determined, essential water quality parameters were not given, and an inadequate number of concentrations were tested.

De Bruijn et al. (1991) - In 1991, a 14-d static-renewal toxicity test was performed by The Netherlands Research Institute of Toxicology on technical grade methidathion (>99%) with one year old guppy *Poecilia reticulata*. No commonly recognized testing methods were used. Two concentrations were tested and controls were not mentioned. Methidathion concentrations were not measured during the test. Water quality parameters during the test were: temperature of 22.4°C; pH of 7.6 to 8.5; hardness of 25 mg/L; and dissolved oxygen of 7.7 to 9.9 mg/L. The lethal body burden value was 0.025 µmol/g fish and 0.0025 µmol/g fish for the high and low concentrations. This test was not acceptable because only two concentrations were tested and no pertinent values were determined.

Table C-1. Values (µg/L) from accepted tests on the chronic toxicity of methidathion to aquatic animals.

Species	Life Stage	Method[a]	Formulation	Salinity/ Hardness	Test Length	Effect	Values	Reference
Cladoceran *Daphnia magna*	<24-h	F,M	Technical (97.2%)	225-275 mg/L as $CaCO_3$	21-d	NOEC LOEC MATC	0.51 1.0 0.71	Forbis 1984
Cladoceran *Daphnia magna*	<24-h	F,M	Technical (96.1%)	170-180 mg/L as $CaCO_3$	21-d	NOEC LOEC MATC	0.72 1.3 0.97	Putt 1991
Fathead minnow *Pimephales promelas*	Early	F,M	Technical (97%)	225-275 mg/L as $CaCO_3$	35-d	NOEC LOEC MATC	6.1 12 8.56	McCallister 1984
Mysid *Mysidopsis bahia*	post-larval	F,M	Technical (100%)	28-31°/oo	21-d	NOEC LOEC MATC	0.022 0.061 0.04	Surprenant 1985

[a] S = Static F = Flow-through M = Measured concentrations U = Unmeasured concentrations

Table C-2. Values (µg/L) from unaccepted tests on the chronic toxicity of methidathion to aquatic animals.

Species	Life Stage	Method[a]	Formulation[b]	Salinity/ Hardness	Test Length	Effect	Values	Reference	Test Deficiencies[c]
Eastern oyster *Crassostrea virginica*	Adult	F,U	N/A	11.8°/oo	7-d		N/A	Ciba-Geigy 1966	1,2,3
Guppy *Poecilia reticulata*	Adult	S,U	Technical (>99%)	25 mg/L as $CaCO_3$	14-d		N/A	De Bruijn et. al. 1991	1,2,3

[a] S = Static F = Flow through M = Measured concentrations U = Unmeasured concentrations

[b] N/A = Not available

[c] 1 = No pertinent values determined
2 = Essential information lacking
3 = Inadequate number of concentrations tested

APPENDIX D. Abstracts of plant toxicity tests

Rufli (1985) - In 1985, a 72-h static toxicity test was performed by Ciba-Geigy on methidathion (96.2%) with freshwater algae, *Scenedesmus subspicatus*. No test standards were mentioned. Five concentrations were tested with three replicates and a water control. Concentrations were measured at the beginning and end of the test and measured concentrations averaged 90% of nominal concentrations. Water quality parameters during the test were: temperature of 22 to 26^{o} C and pH of 6.1 to 9.2. Dissolved oxygen and hardness were not measured. The EC_{50} value based on cell density was 11,000 µg/L.